528A-WV PRESCRIBED GRAZING
APPENDIX 1 - GRAZING GUIDE

Appendix 1 - Grazing Guide

Listed below are the suggested grazing height recommendations. In most cases, if a producer follows these guidelines, the forage resource will be maintained at the desired level.

An exception to these heights is for Management Intensive Grazing operations. If the producer delays initial turnout until these heights are reached, then the successive paddocks will be too mature. Also, depending upon the type operation (dairy, sheep, beef, etc.), the removal height may be different than these recommendations. With dairy, high quality at all times is critical. Therefore, removing livestock earlier may be necessary.

Species [1/]	**Stage of Growth To Star Grazing in Spring**	**Successive Grazings**	**Remove Livestock When Height of grazed Stubble is**	**Over - Winter Height**
Bluegrass	4-5" high (April 20-May 10 for most of WV)	Following a 4-5" regrowth	1-2"	3"
Orchardgrass, Tall Fescue, and other non-jointed grasses	8" high and from boot to early head	Following a 8-10" recovery growth	2-3"	5"
Smooth Brome, timothy, Reed Canarygrass, and other jointed grasses	Before jointing and between early to full head, except smooth brome - medium to full head	8-10" recovery	2-3"	6"
Alfalfa [2/]	Full bud	1/4 bloom or 5-6 weeks recovery	2-3"	6"

Birdsfoot [2/]	1/4 Bloom	1/4 bloom or 6-8 weeks recovery	2-3"	5"
Ladino [2/]	1/4 to 1/2 bloom or 8-10" high	8-10" high; ladino should be 1/4 to 1/2 bloom before last grazing	2"	4"
Red and Alsike Clover	1/4 to 1/2 bloom	1/4 bloom	2"	5"
Crownvetch [2/]	Early bloom	Early bloom	2-3"	5"
Sudan Grass [2/]	18"	--	4"	--
Sudan Grass hybrid [2/]	30"	--	4"	--
Small Grain [2/]	8-10"	Winter grain to be harvested for grain should not be grazed after April 15 for most of WV	3"	--
Switchgrass and Big Bluestem [2/]	18-24" high. Stage of growth between jointing and formulation of a seed head in the stem boot	18-24" recovery growth	8"	8"
Caucasian Bluestem [2/]	14-18" high. Stage of growth between jointing and formulation of a seed head in the stem boot	14-18" recovery growth	6"	6"

[1/] Grazing of grass-legume mixtures should be governed by height of the dominant species.

[2/] These are suited for rotation grazing only. Alfalfa and birdsfoot should reach maturity at least once during season to prolong life of stand.

528A-WV PRESCRIBED GRAZING
APPENDIX 2 - ESTIMATING STOCKING RATE/CARRYING CAPACITY

Appendix 2-Estimating Stocking Rate/Carrying Capacity

The number of animal units that can be supported on the grazing area(s) will depend upon several factors, some of which are:

*current and/or future fertility level
*current and/or planned forage species
*type of grazing system (continuous or rotational)
*number of fields in grazing system
*type(s) of livestock (sheep, dairy, beef, etc.). If beef, the type operation (stocker, cow/calf, etc.)
*grass production potential of the soils
*acres of grazing lands that are harvested for hay at least once during the year
*current and future fence and water availability
*climatic conditions (precipitation, temperature
*grazing efficiency

Once this information is determined, the stocking rate can be estimated by using one of the following references:

1) The "Handbook for Conservation Planning of Grasslands in WV"
2) WVU Fact Sheets:

"Developing a Twelve Month Forage Program"
"Annual Forage Budget - Work Sheet" (Used in conjunction with the above fact sheet)
"Number and Size of Paddocks in a Grazing System"

3) "Missouri Grazing Manual", 1996 Edition
4) WV-CPA 3, WV-CPA 4, and WV-CPA 5
5) Producer's personal knowledge of the farm.

Planners should always ask the producer how many animals he/she has been carrying on the land unit being planned. Too often, the client is either overstocked or understocked. It is the planner's responsibility to determine an acceptable carrying capacity.

The planner should present the information in such a manner that the producer can see how to progress from the current situation to the planned program.

It is very important for the producer to understand that these numbers are estimates based on

current information and that the future carrying capacity may take several years to achieve .

Regardless of which source of information is used, there are two basic methods used to estimate carrying capacity: 1) Animal Unit Months of Forage Required/Available; 2) Requirements Based on Percent Body Weight/Pounds of Forage Available.

1. Animal Unit Months
The Handbook for Conservation Planning of Grasslands in WV (referred to as the Grassland Manual) lists potential AUM's based on Grassland Suitability Groups (GSG), animal class, management level, and precipitation. This information, along with WV-CPA 3 and WV-CPA 4, allows the planner to estimate the forage available and how many animals can be supported. This method is relatively accurate, but it does not consider grazing efficiency - how much of the forage that will be consumed, rejected, or wasted during each grazing cycle. Instructions for using this method are explained in the Grassland Manual.

2. Requirements Based On Percent Body Weight/Pounds of Forage Available
This procedure, although slightly more complicated, takes into account the forage needs of the animal expressed as pounds of dry matter/day, and the actual or projected pounds of dry matter available. It also factors in a grazing efficiency (GE) percentage. Even with a well managed system, rarely will more than 80% of the available forage be consumed during a grazing period. A more realistic number is:

Continuous Grazing 30-40%
3-7 Field Rotation 40-50%
Intensive Rotation 60-70%

Regardless of which system is used, the planner should consider the type of livestock operation. For dairy, a high quality forage is required for optimum production. Therefore, only the top 1/3 or so of the forage should be removed. For beef stocker operation, up to one half of the forage can be harvested, with minimal effect on weight gain. The point to emphasize is that the forage quality must be matched to the type of animal that will be grazing.

To determine how much forage is needed, first determine the total liveweight/acre that will be on the grazing unit. Next, multiply this number by one of the following:

Cow/calf 2.5% of body weight
Dairy (lactating) 3-3.5% of body weight
Dry cows, other 2.0% of body weight

This will then become the total forage needs/day for the herd.

NOTE: It may be desirable to split the various herd groups into separate units, i.e. dairy lactating, dairy dry cows, beef cows, beef calves, stockers, etc. This will be necessary if the producer wants to graze the animal classes separately. (An example would be creep grazing, where the animals with a higher nutritional requirement are allowed to graze an area prior to

animals that require less nutritional quality forages.

The next step is to determine how much forage is available on the grazing unit. Using information contained in the Grassland Handbook, or from the producer, estimate the potential forage production. Multiply this by the total acres available to arrive at the total forage production potential.

EXAMPLE:

50 dairy cows, lactating, avg weight 1200 lb
50 X 1200 X 3.5% = 2100 lbs of DM required per day

From the Grassland Handbook, a soil in the AH Grassland Suitability Group, 40-50 inch precipitation, high fertility, excellent management has the production potential of 7035 lbs of dry matter/ac/year.

The formula for determining the carrying capacity is:

$$\frac{\textbf{Total Forage Production X Grazing Efficiency}}{\textbf{Daily Intake Rate X No. Days in Grazing Season}}$$

If a Grazing Efficiency (GE) of 70% is used, the formula would be:

$\frac{7035 \text{ X } 0.70}{}$ 781 lbs/ac/day
0.035 X 180 days = available during the grazing season

Since the herd requirement is 2100 lbs dm/day, then the field will need to be 2.68 acres (2100 divided by 781).

If the producer wanted 3 days on each field, the field would have to be three times as large, or 2.68 X 3 = 8.04 acres.

Neither of the above procedures recognizes the variations in forage production throughout the grazing season. Unless the producer has a stable forage availability program (by utilizing warm season or other forages), adjustments must be made for forage shortages. This can be estimated by using WV-CPA 3 (Farm Organization Summary) or by the following guidelines:

Typically, with cool season plants, the May-June growth is 50% of total annual production; July-August growth is 33% of total; September-October growth is 17% of total annual production. With warm season grasses, approximately 15 percent of the total growth is in May-June; about 70% of the growth occurs in July-August.

If the producer does not have the warm season/cool season balance, then the planner should offer options on what can be done to provide for the shortfall.

Another way to estimate the forage available is to actually look at the field. **A RULE OF THUMB:** In the vegetative stage, a good, dense sod of desirable forages will contain 250 - 300 lbs DM per inch of height per acre (lb/acre inch). An actual yield measurement would be best, but this is impractical on a continuous basis. However, the producer could gain valuable knowledge early in his/her program if actual measurements were taken, and the planner should offer to assist with obtaining this data.

DETERMINING HOW MANY GRAZING UNITS (PADDOCKS) ARE NEEDED

Obviously, in a continuous grazing system, only one field is needed, since the animals stay in the same field for the entire grazing season. For a rotational system, the number of fields needed will depend on the producer's objectives - time, inputs, and desired outcomes.

If the above example (which is a MIG system) is followed, then enough fields are needed to insure that the first field grazed has time to regrow to the desired height before it is grazed again. **Another rule of thumb:** Through June, it takes about 18-20 days for cool season grasses to regrow to the desired height; it takes 30-36 days for regrowth in August-September. These are guidelines - actual regrowth time will depend upon plant species, geographic location, soil types, rainfall, etc.

The formula for determining number of paddocks is:

REGROWTH TIME
---------- + 1
DAYS ON EACH FIELD

If regrowth time is 36 days: 36 divided by 3 = 12 + 1 = 13 paddocks

In this example, each paddock was 8.04 acres
8.04 ac X 13 paddocks = 104.52 acres total needed

Although 13 paddocks are needed when a 36 day regrowth is calculated, in the spring only 7 paddocks will be needed. The remaining fields can be harvested for hay.

Another acceptable method can be found in Agronomy Field Letter Number 14, revised in 1972. This field letter uses the AUM available/required to determine stocking rate. The formula:

TOTAL AUMs AVAILABLE
---------- = STOCKING RATE
AUMs REQUIRED/ANIMAL/YEAR

NOTE: AUMs required may be for the grazing season only. If AUMs required are calculated for the entire year, then the hay yield must be converted to AUM equivalents.

An example: Dairy cows, 1200 lb avg weight - need 8 months grazing. Grazing land is maximum

tall grass/legume. How many dairy cows can be supported on 120 acres?

From CPA 3, AUMs per acre = 6.4 X 120 acres = 768 AUM's available

From page 1 of Tech Note 14: 1.0 AU/1000 lbs for dairy cows

1.0 X 1.2 = 1.2 AU

1.2 AU X 8 months = 9.6 AUMs

768 AUM's divided by 9.6 AUM's required for 8 months = 78 AU's

DETERMINING WHAT TYPE OF GRAZING SYSTEM IS BEST FOR THE PRODUCER

The type of system employed by a producer depends upon several factors. The planner should explain the advantages and disadvantages of each system. Some of the factors used to evaluate the producer's options are:

*producer objectives *skills of the producer
*available machinery *acres in the planning unit
*producer time availability *financial resources that can be devoted to the
*water facilities available, or planning unit that can be developed

Comparison of Various Grazing Systems

	Continuous Grazing	**3-6 Field Rotational Grazing**	**Management Intensive Rotational Grazing**
Complexity	least amount of effort to provide forage	requires effort	requires considerable effort to establish
Cost	relatively inexpensive-need good perimeter fence and one water water source; fertility level can be meduim	additional fencing and possibly more water facility development	initial expenses may be higher because of need for more fencing, water facility development; need to achieve higher fertility levels
Carrying Capacity	usually lower than other methods - need more acres/au	increased number of au's because of better forage utilization, higher quality, increased quantity	highest of the three methods because of maximum forage yield and highest quality forages

Mgt. Skills Needed	basic understanding of forage/animal relationships	increased because of need to move animals as forage quality and quantity decline	considerable skills needed to keep the forage quality matched to the animal needs throughout the season
Financial Returns	fewer animals, but also fewer expenses; the average daily gain/animal may be higher with this system but the gain/ac is usually less	can support more animals but the increased expense for additional water and fence could offset the benefits; ADG is somewhat less than on continuous but gain/ac is more	highest number of animals/ grazing unit. Initial costs are higher but are offset by higher carrying capacity and total gain/ac; after the system is established and functional, costs generally are less than for other systems

Whatever system is ultimately planned may take several years before it is fully implemented and at the production level established by the producer. Ideally, each succeeding year in a system will show improvements over the preceding year. The planner should provide the producer with estimates of the increase in production (or other significant changes in the operation) for the number of years that it is estimated for the system to reach the producer's objective.

Maintaining The Forage Quantity and Quality

The producer needs to be cautioned that the estimated stocking rate is dependent upon the anticipated quality and quantity of forages. If the actual quality or quantity is different from what is anticipated then adjustments need to be made.

Normally, the first few years in a system will increase the forage quality and quantity. As the program develops, maintenance becomes an important part of the producer's operation.

Lime and fertilizer are essential. Soil testing is a mandatory part of any maintenance program.

Proper maintenance includes close monitoring of the forages. If the percent of a desirable species is declining, the producer needs to evaluate the causes. Planners should assist with evaluating the sward to determine if the quality/quantity is deteriorating and to what extent it will effect the producer's objectives. The planner should make recommendations to the producer on how to correct the problem. This may include changing the stocking rate, manipulating grass height to effect clover composition, or overseeding to increase the percent of the desirable species.

Depending upon the grazing system, clipping may be needed. If there is a weed problem, clipping will usually control most weeds. The planner needs to help the producer decide if weeds are an economic or aesthetic issue, and then decide if clipping is warranted. However, with a MIG system it is imperative that the forage is removed after each grazing cycle. Ideally, there will be enough livestock to harvest the desired amount. If not, then the fields must be clipped (and possibly baled) so that new growth can occur on the entire field.

Sometimes, chemicals are the best solution for controlling undesirable plants. This should be used with caution and only where it is more practical and economically feasible than other methods of control (such as steep areas, areas not accessible to equipment, and where there will be an economic benefit to controlling the undesirable plants). The planner needs to provide information that will help the producer decide if a particular part of a field is economical to maintain as a grazing area.

The environmental concerns with using chemicals should be discussed with the producer. Effects of the chemical on adjacent plants, on surface and groundwater, and on adjoining property need to be addressed.

528A-WV PRESCRIBED GRAZING
APPENDIX 3 - LEGUMES IN MIXTURE

Appendix 3 - Legumes in Mixture

Establishing and Maintaining Legumes

The value of legumes in a grazing system cannot be overemphasized. In addition to the nitrogen fixing value, legumes will improve the animal performance. A field with minimal or no legumes will need the equivalent of up to 200 lbs of nitrogen per acre to achieve the same animal performance as a field with a 30% stand of legumes and desirable grasses. In addition to the monetary savings, beef cattle will gain 1/4 to 1/3 pound per day more on a grass-legume field than on a grass only field. Dairy production will increase by as much as 7-8 lbs of milk/day/animal.

Soil testing is critical if the legumes (or any other grass) are to remain in the field. Apply lime and fertilizer based on the soil test results. CAUTION: The producer should not apply large amounts of nitrogen fertilizer - this may cause the percent legume content to drop because of competition from grasses.

The primary legumes present in WV are clovers. Red clover and Ladino clover are two clovers that are relatively easy to establish and maintain. Other legumes such as birdsfoot trefoil are harder to establish but provide high quality, low cost forage if properly maintained.

Establishment: Both red clover and ladino clover can be frost seeded, no till seeded, or conventionally seeded. Frost seeding has been very successful, provided that the site conditions are adequate (fertility, timing, competition from other plants, etc.). Other, more costly but effective methods to establish forages include complete seedbed preparation and reduced tillage.

For specific recommendations on establishing legumes, refer to the appropriate standard and specification, or to reputable sources such as Penn State Agronomy Guide, WVU Fact Sheets, or Frost Seeding fact sheet. If sources other than NRCS Standard and Specifications are used, document the source in the supporting data of the case file.

Maintaining: Red clover is a biannual and as such will need to be reseeded. Ladino clover is a perennial that spreads by rhizomes. Red clover is upright, and is easily eaten by the animals. Ladino clover is more prostrate and can take a lot of grazing pressure.

Increasing or decreasing the percent of clovers in the field can be achieved by grass height manipulation. If more clovers are desired, the producer should graze the field down to a one inch height to allow more sunlight to reach the clovers. (Remove livestock and allow forages to regrow). If less clovers are desired the grass height should be greater, thus reducing the amount of sunlight reaching the clovers.

528A-WV PRESCRIBED GRAZING
APPENDIX 4 - FERTILITY RECOMMENDATIONS

Appendix 4 - Fertility Recommendations

The amounts of nutrients removed by a plant varies with the management, yield, and type of plant. For example, removing some of the forage for hay will remove plant nutrients. If the hay is fed back on the field, then there is practically a zero loss in nutrients. If animals are allowed to stay in a wooded area, or under a shade tree, or along a streambank, then a large concentration of nutrients will be found there. Management strategies to reduce this problem include limiting access to the areas where animals like to congregate, and locating minerals or salt away from these areas.

In order to insure adequate plant nutrients are available for the desired forage yield, it is necessary to understand how plants, fertilizer, and soils interact. WVU Fact Sheet "Forage Fertilization Based on Yield and Management Goals" (Rayburn, 1996) indicates that with a soil P level of 50 lbs, almost 100% of the soil productivity is achieved. Similarly, a soil K level of 80 lbs will produce almost 100% of the production potential. However, to maintain the same level of crop production, these values must remain constant or higher. In other words, P and K removed by the plant must be replaced or yield will decrease.

The above rates are not meant to be the absolute levels, but are intended to show that most plants can prosper at levels lower than the soil tests indicate. It takes a very good manager to produce the forage needed if the nutrients are at this level. It is usually better to recommend to the producer to apply nutrients based on soil test results.

Soil test reports will recommend lime, P, K, and Mg as needed based on the soil values, type forage desired, and yield goals.

Fertility Recommendations for Various Grasses and Legumes

	Lime	Fertilizer
Alfalfa, ladino	pH of 6.5 to 7.0	Apply based on the soil test results from WVU ot other lab. In the absence of soil test, for site specific recommendations, use worksheet contained in the referenced fact sheet. For N applications, if the field is less than 25% legume, use 5080 lbs N per application. If over 25% legume, N normally not recommended.
All other legumes, smooth bromegrass, reed canarygrass, orchardgrass, switchgrass, big bluestem, and caucasian blustem	pH of 6.0 to 7.0	See above
Kentucky bluegrass, tall fescue, and redtop	pH of 5.6 to 6.5	See above

Warm season grasses and stockpiled fescue have different N requirements. With warm season grasses, apply N annually in late May or June when plants are 12-14 inches tall at 75 lbs/ac. Fertility rates for stockpiled tall fescue are discussed in Appendix 5 - Extending The Grazing Season.

528A-WV PRESCRIBED GRAZING
APPENDIX 5 - EXTENDING THE GRAZING SEASON

Appendix 5 - Extending The Grazing Season

Extending the grazing season has been shown to be more cost effective than feeding purchased or harvested forages. This is true for almost all livestock operations. Even with a high forage requirement such as dairy, grazing the non producing animals will reduce the total cost of the operation. Methods of providing forages for extending the season include grazing crop residues,

planting annuals such as cereal grains and brassicas, and deferring grazing (stockpiling) on some of the fields.

Annual Crops:
Brassicas include rape, turnips, and kale. These are well suited for a high nutrient requirement operation such as dairy. Because of the relatively high costs for planting brassicas, it may not be economical for other enterprises. Rye, barley, oats, etc., as well as sudan-sorghum provide some late summer/early fall forages which are relatively inexpensive to produce. Often sown as a cover crop, they are already part of the producer's operation and can be grazed as long as the soil protection benefits are not removed.

Perennial Forages:
Although smooth brome and orchardgrass can be stockpiled, the quality of both deteriorates rapidly after frost. For this reason, stockpiling these forages should not be an important part of the producer's management plan if a high quality forage is required. The planner should not discount their value but should be aware that the quality may not be adequate for the livestock needs.

One forage that is ideally suited for stockpiling is tall fescue. This perennial grass retains much of its protein and TDN after frost. Also, the palatability improves after a killing frost. Fescue will stand up in snow, making it easily grazed with as much as 8 inches of snow cover.

As with any forage, the soil nutrients need to be available for optimum growth. A soil test should be taken to determine lime, P, and K levels.

If these nutrients are adequate, then all that is needed is N, which should be applied at the rate of 50 to 100 lbs/ac actual N. If the field has 30-35% legumes, there is very little economic value to applying more nitrogen. Stockpiling should begin 45-60 days before the first killing frost. Stockpiling for a longer period will increase the yield, but decrease the quality. The field should be grazed down or clipped, N applied, and the livestock removed. This field will be used after all other forages have been grazed.

The exception to this is if the fescue field has legumes in it. Since clovers lose quality rapidly after a frost, it is preferable to lightly graze the field just prior to or immediately following a frost - but don't remove all the stockpiled fescue. If the clovers are not grazed, the useable forage will be reduced by as much as one half.

This management factor should not deter the producer from establishing and maintaining clovers. Legumes are still more economical than adding purchased fertilizers.

The best way to graze the fescue (or any other stockpiled forage) is by strip grazing. Allow only enough forage for 2-4 days grazing. As each area is grazed down, move the fence to allow additional grazing. This procedure will utilize more of the total forage - less will be lost to trampling, manure, etc.

Properly managed stockpiling will yield 0.5 to 0.6 tons dry matter (DM) per acre per 50 lbs of N applied. One acre of a dense 8-10 inch tall fescue stand will feed as many as 60 cows (1200 lb) for one day.

One method of estimating the value of stockpiled fescue is shown below. (Source: Ohio State University Extension)

Example: 30 head of 1200 lb cows on 12 acres of stockpiled fescue
1 ton of 34-0-0 at $225.00
Apply to 12 acres of fescue, equals 167 lbs/ac
167 lbs/ac X 34% = 57 lbs N per acre
90 days growth - estimate 12 inches high
12 inches X 400 lbs DM per acre inch = 4800 lbs DM
Grazing efficiency 70% = 3360 lbs DM per acre (4800 X .7)
3360 lbs DM/ac X 12 acres = 40,320 lbs DM available
Consumption rate: 3% of body weight = 1200 X .03 = 36 lbs DM/day required
30 cows X 36 lbs DM/day = 1080 lbs DM required for herd
Number of days: 40,320 DM available divided by 1080 lbs/DM/day
= 37 1/3 days

Economics of This Example:

Fertilizer cost per day: $225 divided by 37 1/3 days = $6.03
Fertilizer cost/cow/day: $6.03/day divided by 30 cows = $0.20

What if:

*There were 16 inches of growth instead of 12 inches? 49 3/4 days
*85% grazing efficiency instead of 70%? 45 1/3 days
*1000 lb animals instead of 1200 lb animals? 44 3/4 days
*2.5 % body weight instead of 3% body weight? 44 3/4 days

In summary, it can be shown that stockpiling is cost efficient. If the producer was feeding hay, he would need to feed about one 1200 lb round bale (at 10 % moisture) per day.

1200 lb @ $70/ton = $42 bale
1200 lb bale X 10% = 1080 lb dm
Daily requirement (from above example) = 1080 lb dm
Daily cost for hay = $42.00
Daily cost for fertilizer (from above example) 6.03
Net savings/day from stockpile vs feeding hay = $35.97
Number of Days 37 1/3

Net savings from stockpiled fescue = 1342.76

528A-WV PRESCRIBED GRAZING
APPENDIX 6 - WATER AND FENCING CONSIDERATIONS

Appendix 6- Water and Fencing Considerations

The importance of reliable quality and quantity of water cannot be over emphasized. All systems, regardless of the type of livestock or the grazing program planned, will require an assessment of existing and potential water facilities. **This inventory must be done in the earliest part of the planning process, since success of any grazing program will depend upon adequate water distribution.**

QUANTITY
The quantity of water needed depends upon several factors: the type, number, and size of the animals; air temperature and humidity; type of forages.

A guide for estimating daily water needs for various animals

Animal	**Gal/Day**
Dairy, lactating	35-40
Dry cow	20-30
Heifer	10-15
Calves (1-1.5gal/100 lbs body weight)	6-10
Beef mature	15-20
600 lb	6-10
Swine, finishing	3-5
nursery	1
sow and litter	8
gestating sow	6
Sheep	2
Horse	12

The planner should use this guide in estimating the total water needs for a producer. It may not be necessary for each water facility to be able to provide the total quantity - often the livestock will drink from more than one location. However, in a rotational grazing system, the need for high volume, single source water facilities becomes critical.

When planning a grazing system, the locations of all existing and planned water facilities should be noted on the plan photo. Supporting data indicating that projected water quantity is adequate for the planned livestock operation needs to be included in the case file.

QUALITY

All classes of livestock require a high quality water source. The planner should discuss the positive and negative aspects of water quality with the producer. If the only sources of water are low quality (such as acid mine drainage, sulfur, etc.) then alternative sources such as ponds and wells should be considered.

SOURCES OF WATER

Many times the producer is not aware of the various options for water development. (As a example - most producers have never heard of a ram pump.) The planner should examine all the options, compare the costs and benefits of each, and provide the producer with a recommendation for the system that meets the producer's objectives.
It is particularly important to provide realistic cost/benefit estimates. By using the system cost/animal unit/year, each different system can be compared equally. These recommendations should be part of the supporting data in the case file.

WATER SYSTEMS

Following is a comparison of the more common water facility developments

Source	Portability	Longevity*	Maintenance	Expense
Well	no	med-long; components will vary	fairly difficult-usually requires pulling pump from well	high per well, but cost per acre served is usually low
Public Water	no	long	none on the public part of the system	Varies by PSD-usually less than $2/animal/month
Pond	no	long	minimal-yearly clipping and fence repair	may be high initially but cost per acre served is low

Spring Development	no	long	minimal-periodic removal of sediment	relatively inexpensive; cost per acre served low
Ram Pump	yes	long	minimal-only two moving parts	slightly higher than spring development but cost per acre served may be less than spring or pond
Solar Pump	yes	med-long	considerable-battery, panels, inflow lines, etc.	initial cost is high., but approximately same as small pond; cost per acre served is low to moderate
Electric Submersible Pump	not easily moved	med-long	moderate-check inflow lines, etc. for sediment	moderate-component parts (pressure tank possible water storage structure) will affect cost; cost per acre served is low to moderate
Stream Designed Limited Access	no	long	moderate-replace stone, fencing	moderate-varies with dimensions and type stream flow
Concrete	no	long	minimal	low to moderate; depends on size and manufacturer
Fiberglass	yes; usually not moved	med-long	minimal	inexpensive-less than concrete
Rubber Tire	no	long	minimal	very inexpensive
Others-Bathtubs, Barrels, etc.**	usually moveable without equipment	varies-usually short	continuous but not costly	inexpensive; usually readily available

Longevity Short 3-5 years med 6-10 years long over 10 years

These structures are usually used in a temporary system where the water facility is being moved. Major limitation is storage capacity. Most often will need to be attached to a pressurized water system. However, there are many opportunities for these facilities and the planner needs to inform the producer of this alternative.

FENCING

The quality and degree of permanency for any fencing system will vary greatly depending upon the type of operation and the type of grazing system.

Technological advances in fencing material allow virtually any level of quality and price to be designed into a fencing system. The planner should evaluate and understand the fencing needs of the producer and make recommendations on fencing material, locations, costs, lifespan, and ease of construction. These recommendations should be part of the supporting data in the case file.

It is especially important for the producer to understand the fencing needs for his/her operation. In almost all cases, the planner should stress the need for flexibility in fencing layouts. All that may be needed in a continuous grazing system is a good fence around the grazing unit. If a rotational grazing system is being established, initial fencing should be semipermanent or temporary. This is important for two reasons: First, the cost for temporary fence is small compared to more conventional permanent fence; secondly, the actual locations of field boundaries may not be defined until the producer has been in the rotational system for two or three seasons. As the grazing system progresses, more permanent type fencing can replace the temporary fence if desired. (Note: There may be a need for some permanent fields in any grazing system. For example, the producer may want to separate groups of livestock, or may need to keep males and females separate).

528A-WV PRESCRIBED GRAZING
APPENDIX 7 – TALL FESCUE

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West Virginia University
Extension Service

Forage Management

Edward B. Rayburn, Ph.D.
Extension Forage Agronomist

October 1993

TALL FESCUE

Tall fescue (Festuca arundinacea Schreb.) is a grass adapted to a wide range of growing conditions. It is the best forage grass for late fall and winter grazing and when used in this manner can effectively reduce livestock wintering cost. However, in some situations, tall fescue causes animal production and health problems. Since tall fescue can provide major benefits and major problems, farmer's reactions to this forage species are often mixed and intense.

Description

Tall fescue is a vigorous, perennial, bunch grass which may have short slowly spreading rhizomes. Under good management tall fescue is deep-rooted and forms a dense sod. Tall fescue tolerates wet soils and short periods of flooding and is also drought tolerant. It is tolerant of low soil pH but is most productive when the soil pH is 5.8 or greater, phosphorus and potassium are medium to high, and soil nitrogen is readily available. Because of its wide range of site adaptation and its vigorous seedling growth, tall fescue is often used to seed roadsides and reclaimed disturbed areas.

Under good growing conditions tall fescue will grow to 48 inches or more in height. The seed head is a loosely branching panicle (Figure 1). The leaf of tall fescue is rolled in the bud stage (when the leaf is in the previous leaf sheath) and the plant has a round tiller base (Figure 2). The leaf blades are 1/8-1/2 inch wide and 4-24 inches long. Tall fescue leaves are a yellowish to dark green color depending on the availability of soil nitrogen. The upper leaf surface is dull with distinct veins running the length of the leaf. The lower leaf surface is smooth and glossy and is slightly keeled. The leaf margin is rough.

There is a distinct collar between the leaf blade and the round leaf sheath or "stem". This collar is broad, hairless and yellow green to cream in color. At the front of the collar there may be short, blunt, claw-like auricles 0.5 - 1.5 mm long. Where the

Figure 1. Tall fescue seed head, plant crown showing reproductive and vegetative tiller seed and flower spikelet.

collar meets the sheath there is a short, greenish, membranous ligule about 2 mm long.

Tall fescue is similar in appearance to ryegrass. In fact, some of the modern fescue varieties are hybrids of fescue and ryegrass. Tall fescue is different from perennial ryegrass which has a leaf that is folded in the bud stage. Tall fescue is different from Italian ryegrass which has a smooth leaf margin and a longer, more prominent ligule.

Tall fescue goes to head later than orchardgrass and Kentucky bluegrass. It is similar to these two grasses in that its growing point remains near the ground during vegetative growth. Tall fescue maintains most of it's carbohydrate energy reserves in the tiller bases.

Tall Fescue Endophyte

About 80 percent of the tall fescue stands in West Virginia are infected with a fungus called an "endophyte" (Acremonium coenophialum). An endophyte is a fungus that grows inside another plant, without causing any apparent harm to the host plant and in some cases providing benefits to the host. The tall fescue endophyte appears to be a fungus which benefits the fescue plants. This endophyte produces chemicals called "alkaloids" which protect the tall fescue from insects and nematodes making the plants more tolerant to marginal soil environments and harsh management conditions. Some of these alkaloids are the cause of poor animal performance and health when consumed at too high a level. The complex of performance and health problems is often called "fescue toxicosis". The main effect of endophyte alkaloids on ruminant livestock appears to be on heat regulation and feed intake. In horses the alkaloids can cause abortions and reduced milk production in mares consuming infected tall fescue during pregnancy.

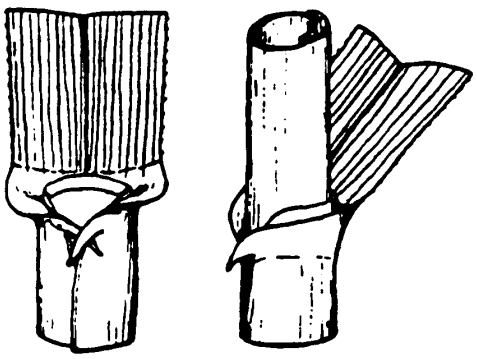


Figure 2. Vegetative characteristics of the tall fescue leaf, leaf collar, ligule, auricles and leaf sheath.

Ergovaline is one of the endophyte alkaloids. This alkaloid causes the constriction of blood vessels in animals. One result in cattle is reduced blood flow in blood vessels and capillaries under the animal's skin. When cattle are in a warm environment, the main way they have of losing heat from the body is to increase the blood flow through capillaries under the skin. This blood flow carries heat from the inner part of the body to the surface where the heat is lost to the air. However, if an animal consumes enough alkaloid to constrict these capillaries, the volume of blood flow and the amount of heat moved to the body's surface will be reduced. The animal will then be more subject to heat stress during of warm weather. A good analogy is an old tractor radiator. If you have an old radiator which leaks and you repair it by soldering up part of the core, it may do fine in cool weather but will over heat during hot weather. Cattle grazing endophyte infected tall fescue during the winter don't seem to have as much of a problem. During the heat of summer cattle grazing endophyte infected tall fescue spend a lot of time in the shade or in ponds or creeks trying to keep cool. This heat stress may cause reduced feed intake and decreased animal performance. Early embryonic death in cattle during hot weather may also be related to this heat stress.

The life history of tall fescue and its endophyte shows us some things to consider when managing tall fescue to reduce fescue toxicosis. In the cool, spring weather the tall fescue plant is leafy and palatable. The leaf's growing point is at or below the soil surface. In this vegetative growth stage the endophyte is located in the fescue's leaf sheath (the "stem" of the leaf below the flat blade). In May the fescue plant starts to produce reproductive tillers which develop growing points that rise above the soil surface, pushing the seed head up through the leaf sheath. As the fescue plant produces reproductive stems, the fungal endophyte moves up into the stem from the leaf sheath. As the seed head and seeds develop the endophyte moves into the seed head and invades the new seed. When the seeds fall to the ground and germinate the endophyte in the seed infects the newly formed plant, continuing the cycle. It appears that the only way the tall fescue endophyte is transmitted to a plant is through the seed from infected plants.

Endophyte infected tall fescue can become a serious weed in pastures since the infected plants are less palatable than other forages. This leads to the

livestock grazing the more palatable orchardgrass, bluegrass, and clover plants; leaving the infected fescue plants to grow and go to seed. Since the infected seeds are vigorous and resistant to insects, nematodes, and drought they can be very competitive. This allows tall fescue to rapidly invade a field.

Managing Tall Fescue for Fall and Winter Grazing

Livestock producers have mixed feelings for tall fescue due to the poor animal performance this forage. When tall fescue is used as part of a forage system containing other forage species, with the tall fescue being used primarily in the spring and winter seasons, there is seldom a problem. One of the best uses of tall fescue is for late fall and winter grazing. This is called "stockpiling" or "deferred grazing". Stockpiling is the accumulation of forage during a period of active growth for use when forage growth is slower. In late fall and early winter well managed stockpiled tall fescue is leafy, palatable, and high in protein, sugars, and digestibility. When tall fescue is used in the late fall and winter months when the weather is cool, the cattle are less liable to be heat stressed and perform better than when the forage is used in the warm summer months. Deferred grazing is a cost effective and environmentally friendly way of wintering dry beef cattle, ewes, and stocker cattle held for grazing the following summer.

Yield and quality of stockpiled tall fescue will be increased by providing adequate nitrogen for late summer and fall growth. This can be accomplished by growing the fescue with clovers or by applying nitrogen in the form of commercial fertilizer, manure, or chicken litter. Adequate nitrogen is needed to allow fescue to grow actively, produce proteins, and accumulate sugars during the cool fall weather. This results in the fescue being more tolerant to freezing as the weather turns cold and provides a greener, higher quality forage for grazing during the winter.

Tall fescue fields which have small amounts of legumes in them will respond well to nitrogen fertilization if the other plant nutrients and soil moisture are available. Nitrogen fertilized tall fescue will withstand freezing weather better than fescue grown with legumes. When using nitrogen, apply 50-100 pounds actual nitrogen per acre, depending on the amount of forage desired. Stockpiled tall fescue produces .50-.60 tons additional dry matter per 50 pounds of nitrogen applied. Fertilizer nitrogen should be applied soon after stockpiling starts. If using urea, apply it just before a rain to reduce the loss of nitrogen by volatilization.

Tall fescue stands containing over 30-50% legume, will show little economic value from applying nitrogen for increased production. When red clover is the legume, the stand, can be managed for maintenance of the legume by properly timing grazing relative to seed production and frost. When using legumes to provide nitrogen, the fall growth can be lightly grazed to use the legume growth before it is lost to the freezing weather. This can be done with weaned calves to make the best use of the high quality legume forage. The grass can then be saved for later use by dry cows. If the legume forage is not used before or shortly after frost the usable forage yields from these legume-tall fescue stands may be reduced by half. Tall fescue clover stands should be grazed close during the winter or spring to encourage the establishment of legume seedlings. Dragging the pasture in early spring will spread the manure and seeds, ensuring a better distribution of seedlings and plant nutrients. By grazing the area after dragging the cattle will walk the seed into the soil surface improving seedling establishment.

Stockpiling tall fescue for winter grazing has to be planned. Due to low light intensity and cool temperatures little forage growth will occur after mid-October. For high yield and quality, deferral of tall fescue should begin between mid-July and mid-August. The earlier forage stockpiling starts, the greater the late fall and winter yield will be. If fescue is stockpiled before July quality will be lower and yield about the same. Research shows that 84% of the variation in stockpiled tall fescue yield can be accounted for by the number of days the stand is allowed to stockpile (Days) and the interaction of the number of days regrowth and the rate of nitrogen fertilizer applied at stockpiling (Nrate). There is also an effect of the location and year on dry matter yield. This location or year effect is due to differences in fall weather, soil conditions and management before stockpiling and at the December harvest. The location and year can change dry matter yields by $\pm$500 pounds per acre. The following equation predicts the effect of days regrowth and nitrogen rate on December dry matter yield within $\pm$500 pounds per acre.

Dry matter yield = (17.6 x Days) + (0.08246 x Days x Nrate) - 767

Forage quality of stockpiled tall fescue is adequate for beef cows and ewes and is better than much of the hay put up for these animals. If fertilized with 50-100 pounds actual nitrogen in July or August the forage harvested about the first of December will yield 1 - 2 ton forage dry matter ranging between 11-16% crude protein and 60-65% digestibility.

To decrease waste of the forage and provide more uniform nutrition for the animals, rotationally graze the stockpiled tall fescue. If animals are allowed free access to stockpiled tall fescue they will eat only a part of the forage and trample much of the feed into the ground. By providing only what the herd will consume in 1-7 days, more forage will be eaten and less walked into the ground. One acre of a dense 8-10 inch tall fescue stand will feed 66 cows weighing 1200 lb. each for 1 day. In extremely cold weather forage intake may be higher.

Cattle will graze stockpiled tall fescue through fresh snow up to 8 inches deep. However, if the snow has a hard crust cattle will require supplemental feeding. Sheep learn how to paw the snow off stockpiled feed and can graze through the snow as well as or better than cattle.

Close grazing of the forage will increase use of the feed and can decrease the competitive nature of endophyte infected tall fescue in the spring. This will help maintain more legumes in the stand for use during the spring and summer grazing season. If you have seeded endophyte free tall fescue leave more stubble (2-4 inches) at the end of the grazing cycle to provide for a vigorous spring growth of tall fescue which will help ensure long term stand persistence. When grazing tall fescue during cold weather, livestock do not refuse the forage near manure piles as they do during summer grazing.

Managing Endophyte Infected Tall Fescue in the Summer

Daily gains of yearling steers grazing endophyte infected tall fescue decrease about 0.1 lb./day/ 10% increase in endophyte infection level. To improve summer performance, endophyte infected tall fescue can be managed to encourage other forages in the stand, which will dilute the effect of the endophyte. These forages can be grasses like bluegrass or crabgrass, or legumes such as red or white clover. Maintaining a legume in the stand will allow animal gain to increase by about 0.3 lb./day over nitrogen-fertilized infected fescue. To maintain legumes in a tall fescue stand, lime and fertilize the field to maintain a soil pH of 5.8 - 6.5 and a phosphorus and potassium soil test in the medium to high range. Avoid using nitrogen fertilizers such as poultry litter, manure, or commercial nitrogen fertilizers. Application of these materials to tall fescue stands, especially in the spring, will stimulate the grass growth, smother out clovers, and increase fescue toxicosis.

When grazing endophyte infected tall fescue don't let it grow too tall in the spring before turning in the cattle. If rotationally grazing endophyte infected tall fescue, turn the cattle in when the grass is 4-6 inches tall and graze to a 1 inch stubble height. This management allows white clovers and Kentucky bluegrass to be more competitive, increase in the stand and dilute out the toxic effects of the infected fescue. If continuously grazing endophyte infected tall fescue pasture try to maintain a short canopy (2-3 inches tall) to encourage white clovers and bluegrass. Clip the tall fescue flower heads early to prevent seeding and to prevent cattle consuming the seed heads which are high in alkaloids. This will also result in better tillering and vegetative regrowth When harvesting tall fescue for hay, take the first cut when the grass is in the late boot or early heading stage of development. This will minimize the amount of alkaloids in the forage and maintain forage quality so that feed intake will be higher.

Eradicating Infected Tall Fescue Stands

In most cases fescue toxicosis can be reduced or eliminated by management which reduces the intake of the toxic alkaloids by increasing other grasses and legumes in the forage stand. Another option is to use infected tall fescue at times of the year when the animals are less affected by the endophyte alkaloids. This would be in the cool weather of spring and late fall and winter to prevent the heat stress induced by the alkaloids. However, there maybe situations when the eradication of endophyte infected tall fescue is economically the best alternative. This occurs on highly productive soils where a relatively high value animal product is being grown.

Eradication of an existing endophyte infected tall fescue stand is the last management option recommended. The practical success of the other two options, the costs and risks associated with killing an established sod, and establishing a new sod weigh heavily against this option. Evaluate your expected returns and costs carefully before pursuing this alternative.

Three management decisions have to be addressed and adhered to in order to make eradication a success. Is the manager willing to:

1. commit to the management required to kill the endophyte infected stand,
2. commit to preventing the reintroduction of endophyte infected seed,
3. commit to managing the new seeding for stand maintenance?

If you decide that the eradication of an infected tall fescue sod is the best option and the answer to the three questions are all yes, be prepared to take

two years to accomplish the task. The steps required are:

1. select a site on which machinery can be used;
2. soil test and add the lime, phosphorus and potassium needed for establishing a grass clover stand;
3. plan for the exclusion of endophyte infected seed to prevent the encroachment of new infected fescue seedlings;
4. prevent seed head formation by the infected fescue plants for one to two growing seasons before killing the stand;
5. kill the infected stand by growing a cultivated crop for two years or by using herbicides and no-till or minimum-till site preparation and planting;
6. prevent reintroduction of infected tall fescue seed to the field from seed on haying equipment; seed in winter fed hay, manure and bedding; or in manure from cattle which previously grazed in an infected fescue pasture containing ripe seed heads,
7. manage for the maintenance of the perennial species established.

It is possible to eradicate endophyte infected tall fescue and establish other perennial forages such as orchardgrass and endophyte free tall fescue. These forage stands can be maintained for years if the manager prevents the introduction of endophyte infected tall fescue seed and maintains the established forage through proper harvest and fertility management.

Managing Endophyte Free Tall Fescue

Tall fescue varieties which are free of the endophyte are available. These varieties are more palatable and will not cause health and performance problems encountered with infected tall fescue. However, endophyte free varieties require more careful management than endophyte infected varieties.

New varieties of endophyte free tall fescue are developed by placing seed in a warm dry environment which kills the endophyte but retains seed viability. Keeping infected tall fescue seed in a warm dry room for 12 months will kill the endophyte while most of the seed will remain alive. The endophyte free seed is then planted and the seed produced by these plants is free of endophyte and sold as endophyte free seed.

When rotationally grazing endophyte free tall fescue-clover stands, start grazing when the plants reach an 8-10 inch height and remove the livestock when they have grazed most of the stand to a to 2-3 inch stubble. Preferably use rotational grazing with a paddock occupation period of 7 days or less. Longer grazing stays or continuous grazing may result in overgrazing and the death of the endophyte free plants. In the spring it will take about a 3 week rest interval, while in the summer it will take about a 5-6 week rest interval for the plants to reach the desired pregrazing height. Use legumes such as ladino and red clover in the stand to supply nitrogen and to obtain increased animal performance.

Note that the recommended management for endophyte free tall fescue is much different than that for infected tall fescue. The recommendations for the infected tall fescue are designed to reduce the vigor of the tall fescue plants and encourage other grasses and legumes which are tolerant to close grazing to invade the stand and dilute out the toxic effects of the endophyte. The management of endophyte free fescue is desired to maintain a healthy vigorous tall fescue stand which will resist the encroachment of weeds, including endophyte infected seedlings which might get into the field.

528A-WV PRESCRIBED GRAZING
APPENDIX 8 – USE OF BRASSICA CROPS TO EXTEND THE GRAZING SEASON

SMALL GRAINS AS FORAGE CROPS

NAT-NRCS. June 1994

WV-NRCS, FOTG-IV, May 2000

Use of brassica crops to extend the grazing season

Cool-season perennial grass and grass-legume pastures typically become less productive as the grazing season advances from June to November. Forage brassica crops such as turnip, swede, rape, and kale can be spring-seeded to supplement the perennial cool-season pastures in August and September or summer-seeded to extend the grazing season in November and December. Brassicas are annual crops which are highly productive and digestible and can be grazed 80 to 150 days after seeding, depending on the species (see table on back page). In addition, crude protein levels are high, varying from 15 to 25 percent in the herbage and 8 to 15 percent in the roots, depending on the level of nitrogen fertilization and weather conditions.

SPECIES AND VARIETIES

Kale *(Brassica oleracea* L.*)*

Varieties of kale differ markedly in winter hardiness, rate of establishment, stem development, and time required to reach maturity. The stemless type kale (e.g. 'Premier') has a faster rate of establishment than varieties which produce stems. Crop height of the stemless type is approximately 25 inches, whereas that of narrow stem kale is 60 inches with primary stems often 2 inches in diameter. Stemless kale attains maturity in approximately 90 days, allowing two crops per year, whereas varieties that develop stems require 150 to 180 days to attain maximum production. 'Premier' has consistently survived winters in central Pennsylvania, whereas other varieties of kale usually are winter-killed in December.

Rape *(Brassica napus* L.*)*

Mature forage rape is one of the best crops available for fattening lambs and flushing ewes. Rape is a multi-stemmed crop with fibrous roots. The stems vary in length, diameter, and in palatability to livestock. Forage yields of spring-planted rape increase until plants become physiologically mature. Growth slows or ceases at maturity and yields plateau until leaves senesce and die. Varieties differ in when this occurs, however, 'Rangi' rape retains its leaves longer than most varieties. Generally, yields of rape varieties in Pennsylvania are maximized with two 90-day growth periods. However, performance of 'Emerald' and 'Winfred' rape varieties is best with one 180-day growth period, and yields of rape hybrids are greatest with 60 days of growth before the first harvest and a 30-day growth period before the second harvest.

Swede *(Brassica napus* L.*)*

Like turnip, swede produces a large edible root. Swede yields are higher than those of turnip, although growth is slower and requires 150 to 180 days to reach maximum production. Swede usually produces a short stem (neck), but can have stems 2 1/2 feet long when grown with tall crops which shade the swede. Unfortunately, stem elongation is at the expense of root development. The variety 'Calder' is cold hardy in central Pennsylvania and thus ideal for stockpiling and for late fall or early winter grazing. In general, all swede varieties are recommended for late fall grazing.

Turnip *(Brassica rapa* L.*)* or Turnip hybrids

These crops grow very fast, reaching near maximum production levels in 80 to 90 days. Studies in southwestern Pennsylvania showed that turnip can accumulate dry matter in October as fast as field corn does in August. Growing "out of season" (October/November) makes turnip a valuable crop for late fall grazing.

The proportions of tops and roots varies markedly depending on variety, crop age, and planting date. Research by the USDA Pasture Laboratory showed that turnip crops can vary from 90 percent tops/10 percent roots to 15 percent tops/85 percent roots. Some hybrids have fibrous roots which will not be readily grazed by livestock. All varieties produce primarily tops during the first 45 days of growth. Sixty to 90 days after seeding, turnip varieties such as 'Savannah' and 'All Top' continue to produce a high proportion of tops. During the same period, other turnip varieties have nearly equal top and root production, except 'Purple Top' has a greater root than top production. The significance in the proportion of tops and roots is that the crude protein concentration (8 to 10%) of roots is approximately one-half of that in turnip tops. Therefore, greater root production tends to reduce the crude protein yield of the total crop. On the other hand, stockpiled tops appear to be more vulnerable to weather and pest damage than roots. Varieties differ in their resistance to diseases, but this often is not evident until the crop is more than 80 days of age and the plants are reaching full production.

Other forage brassicas

Several hybrids of brassica species are also used as forage crops, however, there is limited research information on the production and management of these hybrids. The more common hybrids include a cross between Chinese cabbage (*Brassica campesteris sensulato* L.) and rape ('Perko'), turnip ('Tyfon' and 'Buko'), and swede ('Wairangi').

ESTABLISHMENT

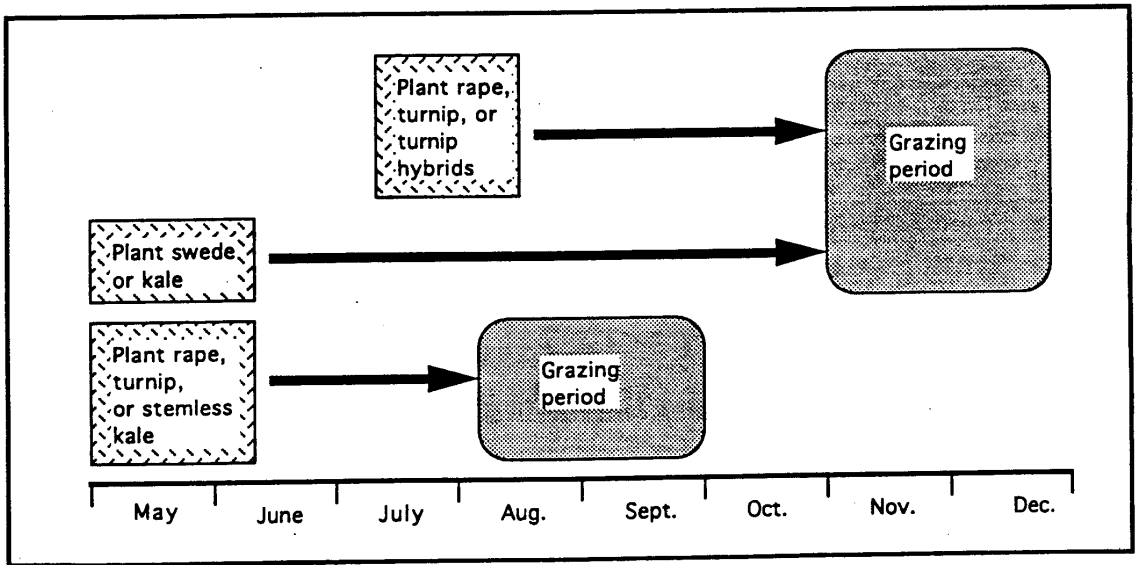
All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production. Good stands can be established by planting 3.5 to 4 pounds per acre of kale or rape, or 1.5 to 2 pounds per acre of swede or turnip. The higher seeding rates are recommended for spring plantings. The seeds should be planted in rows 6 to 8 inches apart and not more than one-half inch deep. However, brassica seed can also be broadcast and incorporated into tilled seedbeds by cultipacking. When preparing a tilled seedbed for brassica planting, plow the ground several weeks before planting to allow weed seeds to germinate before secondary tillage is completed to form a firm and fine seedbed that is free of weeds. In addition, the preplant incorporated herbicide, Treflan (Trifluralin), is labeled at 0.5 to 1.0 pint active ingredient per acre for control of annual grass and small seeded broadleaf weeds in brassicas.

Brassica stands can also be established by no-till planting in grass sod that is suppressed with paraquat or glyphosate herbicides. Read pesticide labels and precautions before using either of these herbicides. Ideally, the grass sod should be grazed through June with the grazing prior to brassica seeding being very close. Approximately two weeks before planting the herbicide should be applied to the grass sod. Another option for no-till establishment would be to apply a manure slurry to the sod, to burn the sod back, and then no-till plant the brassica seeds through the slurry. In addition to reduced erosion concerns with no-till planting, there are generally fewer insect problems than with conventionally seeded brassicas. The following recommendations will improve the chances of successful brassica establishment.

1. Attempt establishment only on well drained soils.
2. Do not seed deeper than one-half inch.
3. When seeding into a sod, suppress the sod long enough to allow the brassicas to establish (two to three weeks).
4. Apply 75 pounds of nitrogen at seeding to stimulate establishment and growth.

As previously mentioned, forage brassicas can be grown to supplement perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June because spring rains will help assure production for August and September grazing (Figure 1). Turnip, rape, or stemless kale could be used for this purpose. In the second instance, swede or kale would be planted in spring, or rape, turnip, and turnip hybrids would be planted in late July or early August, and growth allowed to accumulate until November or December.

Figure 1. Planting and grazing sequence for forage brassicas.



MANAGEMENT

Fertilization

Phosphorus and potassium soil test levels should be in the optimum range prior to planting. If the phosphorus level is below 55 pounds per acre, the application of phosphorus during brassica development may be warranted. Application under this condition tends to increase yield if nitrogen is not limiting growth. However, phosphorus applications decrease crude protein concentration of the brassica forage.

In addition to the nitrogen applied at planting, when multiple grazings are planned, an additional 70 pounds should be applied between 60 and 80 days after seeding to increase yield and crude protein level of the brassica tops. Unfortunately, the nitrogen induced yield increase in turnip and swede tops causes a reduction in root yield. When seeding into a suppressed grass sward, nitrogen application tends to increase the efficacy of the suppressing herbicide and reduces the proportion of grass in the brassica-grass sward.

Grazing

Brassicas can be harvested for greenchop or silage but are most frequently grazed. Grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassica at a time provides the most efficient utilization (Figure 2). Grazing large areas increases trampling and waste of the available forage. Rape is more easily managed for multiple grazings than are the other brassica species. Approximately 6 to 10 inches of stubble should remain after grazing rape to promote rapid regrowth. Regrowth may be grazed in as few as four weeks after the first grazing. Graze rape close to ground level during the final grazing.

When turnips are to be grazed twice, only the tops should be grazed during the first grazing. Turnip regrowth is initiated at the top of the root, so this part of the plant should not be removed until the second and final grazing when the whole plant can be consumed. Like rape, regrowth of turnips can be sufficient to graze within four weeks of the first grazing.

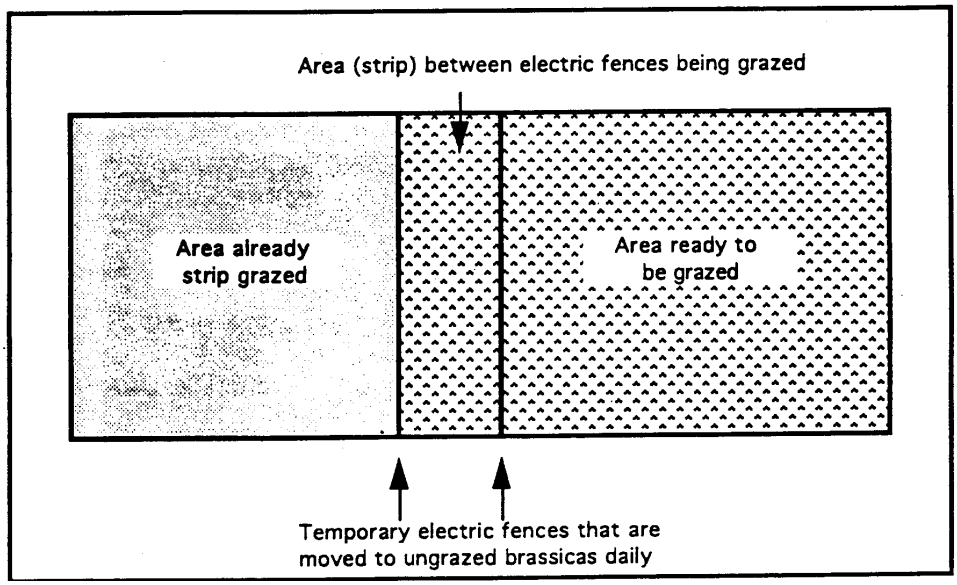
Pests

Diseases such as bacterial soft rot of brassica roots and leaf spot are generally not a problem until the plants near maturity. Stockpiling (delaying grazing until a date later than plant maturity) should not be attempted in fields were brassicas have high levels of foliar disease at maturity. Research has shown yield reductions of 40 percent when disease infected brassica crops were stockpiled for 45 days. Generally, 'Forage Star' turnip and 'Rangi' rape are better suited for stockpiling than are other varieties because of lower disease infestation. To reduce disease occurrence, brassicas should not be grown on the same field for more than two consecutive years.

Insects that feed on brassicas , such as aphids, flea beetles, and imported cabbage worms, are not a consistent problem in Pennsylvania. However, appropriate use of insecticides may be warranted if insect populations become severe.

Once established, brassicas are very competitive with weeds. However, precautions should be made at planting to reduce weed competition during brassica establishment.

Figure 2. Example of strip grazing method for brassica grazing.



YIELD AND NUTRITIONAL VALUE

Brassica dry matter yield will depend on the production potential of the soil and environment, and the brassica species. Average yields in Pennsylvania have been 3.1 tons of dry matter per acre at 90 days after planting. Slower naturing kale and swede average over 4 tons per acre at 120 days after planting. For a grazing situation, an average carrying capacity of a good brassica stand would be approximately 1,550 ewe-grazing or 160 cow-grazing days per acre.

Dry matter digestibility generally exceeds 90 percent for all plant parts except kale stems at maturity. By comparison, dairy quality alfalfa hay is approximately 70 percent digestible. With adequate fertility, brassicas can produce amounts of digestible energy per acre equivalent to corn yielding 115 bushel per acre. Unlike perennial forage crops, the dry matter digestibility of brassicas does not decrease markedly with increasing plant maturity. This characteristic makes them ideal for stockpiling. Ruminant diets should not contain more than 75 percent brassica forage because the fiber content of brassica crops is too low for maintenance of proper rumen activity. With their high digestibility and low fiber content, brassicas should actually be considered as "concentrates" rather than "forage" in nutritional planning for livestock. Crude protein concentration of brassicas ranges from 8 to 10 percent in turnip roots to 30 percent in rape leaves.

FEEDING CONCERNS

Brassica crops can cause health disorders in grazing animals if not managed properly. The main disorders are bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism, and polioencephalomalacia. Researchers have discovered that these disorders can be avoided by adhering to two management rules:

1. Introduce grazing animals to brassica pastures slowly. Avoid abrupt changes from dry summer pastures to lush brassica pastures. Don't turn hungry animals that are not adapted to brassicas into a brassica pasture.
2. Brassica crops should not constitute more than 75 percent of the animal's diet. Supplement with dry hay if continually grazing brassicas or allow grazing animals access to grass pastures while grazing brassicas. No-till establishment into existing sod will reduce the risk of these disorders because of grass in the brassica pasture.

SUMMARY

Brassica crops can produce high yields of highly digestible forage during periods when perennial forages have limited production. In addition, the digestibility of the forage remains high over a relatively longer period than perennial crops. Few crops offer as much potential as do brassicas to improve livestock carrying capacity from August through December. Spring-seeded brassica crops can be used to supplement low producing cool-season pastures or as insurance against summer drought. Summer-seeded brassicas can extend the potential grazing season by providing forage for fall and winter grazing. These characteristics make the use of brassica crops in grazing situations very flexible and appealing to producers utilizing pastures in their livestock operation.

Table of characteristics and seeding rate of brassica forage crops.

Crop	Plant part consumed	Seeding to harvest (days)	Regrowth after harvest	Seeding rate (pounds/acre)
Kale	herbage	150 to 180	no[a]	3.5 to 4
Rape	herbage	80 to 90	yes	3.5 to 4
Swede	herbage and root	150 to 180	no	1.5 to 2
Turnip	herbage and root	80 to 90	yes	1.5 to 2

[a]An exception is the stemless variety 'Premier' which is ready for harvest 80 to 90 days after seeding and will regrow after harvest if not grazed below 3 to 4 inches.

Prepared by Marvin H. Hall, assistant professor of agronomy, and Jerry Jung, adjunct professor of agronomy.

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Forage Management

Edward B. Rayburn
Extension Forage Agronomist

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Small Grains as Forage Crops

Annual small grains such as oats, barley, rye, and wheat are productive, high quality forages. They play an important role in livestock production on the national level. Many lightweight calves are grazed over the winter on the acres of wheat pasture in the midwest before going into southwestern feedlots. In the south, rye and winter oats are often grown to provide winter grazing for cattle and sheep. Small grains have potential for providing early spring grazing, additional hay or silage, or supplemental summer grazing. They can be of help in pasture or hay land renovation by providing forage and reducing soil erosion while establishing a new seeding.

The annual grains of most value in West Virginia are spring oats, winter barley, rye, winter wheat, and triticale. Spring oats are a common crop in the state and well adapted to our climate and acid soils. Rye is also well adapted to our climate and the best cereal crop for acid or wet soils. It produces good early grazing and gives a field very good erosion protection over winter. If grazing dairy cows on rye, they should be removed 3-4 hours before milking to prevent off-flavored milk. Some rye varieties, like Balbo, are reported not to cause this problem.

Triticale is a hybrid between wheat and rye. Triticale varieties adapted to our area are highly productive. Some varieties are more tolerant to acid, wet soils like the rye; but other varieties are more like wheat requiring higher pH and better drainage. Because of its wheat parentage triticale is less likely to cause off-flavored milk and may be more palatable than rye.

When planted for forage production, annual cereals should be fertilized and managed as for a grain crop. For best production oats should be planted from late March too early May, depending on elevation. Rye, wheat, barley, and triticale are normally planted in the early fall. Rye and some triticale tolerate acid soils so they do not need a high pH. They can be grown on acid sites while applied lime has a chance to react with the soil for the growth of perennial legumes and grasses which may be planted afterward. Wheat and barley are more sensitive and should be planted on sols which are better drained and have a pH from 6.0 to 6.5 or above.

Legumes and perennial grasses can be frost seeded during the winter or no-till seeded into the stubble after chopping the forage for silage or after grazing. Such sites are very well adapted to no-till seedings. For spring seeded oats the perennial forages can be under-sown at the time of seeding the oats.

Soils should be tested to ensure that adequate phosphorus and potassium are applied at seeding time to provide for the small grain forage and the new permanent seeding. On low fertility soils 60 pounds of nitrogen, 85 pounds of phosphorus, and 70 pounds of potassium are needed if the stand is under-seeded to a perennial forage.

Forage yields and quality are highly dependent on soil fertility, soil moisture during growth, and growth stage at harvest. For winter barley or spring oats, a late boot to milk stage of growth will provide the highest production of palatable, high-quality forage. At these growth stages, 1.5-2.5 tons of dry matter per acre can be harvested depending on fertility and harvest management. Digestibility will be between 58 and 67% TDN and crude protein will range between 10 and 16% (Table 1). If nitrogen is not adequately supplied from soil organic matter or commercial fertilizer, yields and crude protein content will be lower. The other small grain crops will give similar or higher yields. Rye should be chopped in the late boot stage or can be

grazed in the late jointing to early boot stage of growth. Rye will become less palatable if allowed to mature too far. For early spring grazing, rye should be planted on drier fields so that wet soils do not prevent grazing at the proper growth stage.

If you have land open after harvest or if you could use a little more silage or pasture in early spring consider growing a small grain for a cover crop which will reduce erosion during winter. Or during the spring establishment of a perennial forage seeding, consider growing a small grain nurse crop to control weeds and provide additional forage or mid-summer grazing.

Table 1. Forage quality of small grains harvested for silage as measured by the Northeast DHIA Forage Testing Laboratory.

Forage	No.[1]	DM	CP	ADF	NDF	TDN
Barley	115	35 ± 9[2]	12± 3	36 ± 6	56 ± 7	64 ± 5
Oat	354	36 ± 11	14 ± 3	39 ± 5	59 ± 6	61 ± 4
Rye	193	33 ± 10	14 ± 3	37 ± 5	58 ± 7	63 ± 4
Triticale	61	32 ± 10	15 ± 5	38 ± 5	57 ± 9	62 ± 4
Triticale/pea	455	36 ± 10	17 ± 3	37 ± 4	53 ±6	62 ± 3

[1] Number of samples analyzed.
[2] Mean plus range which contains 67% of observations (± 1 standard deviation).